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J. Nvota, D. Lamosova, D. Tesarova, V. Cierna, P. Vyboh

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INFLUENCE OF HYPOKINESIS ON PHYSIOLOGICAL FUNCTIONS IN FOWL

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The current trend in modern large-scale poultry keeping seems /425* to increasingly point toward cage keeping due to its operational and economic advantages. These technologies make an increasing use of technically equipped media with controllable components which could habe unintended effects on the development of the kept animals. The characteristic trait of the cage keeping method is its substantial restriction of movement. It is therefore important to determine to which extent such restriction of movement affects physiological functions that control the animals' productivity. As a model of restricted movement we chose to place the animals into tight cages, similar to those used in experimental work in the area of cosmic biology, in order to be able to compare our results obtained with poultry with results obtained with laboratory mammals, as information regarding the effects of hypokinesis on the physiological functions of agricultural fowl is extremely scarce. Having thus oriented our research we undertook our experimental work.

According to literary sources, endocrine reactions to restricted movement differed from one species of laboratory mammals to another. Tomasevska et al (1970) determined that hypokinesis in rats produced increased activity in the adrenal gland in the first several days. /426 However, after 30 days of restircted movement the level of corticosterone in the blood plasma decreased to the level shown by the control animals. On the other hand, Fedorov and Nevstrujeva (1969) determined that in rabbits the level of corticosterone in the plasma was lower both in the beginning phase and after 30 days of hypokinesis.

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*Numbers in the margin indicate pagination in the foreign text.

According to Gurovskij et al (1974) the thyroid gland of rats reacts by increased activity in the initial as well as in the later stages of hypokinesis. We arrived at comparable results (Nvota et al, 1970) in experiments with repeated immobilization of chickens. We were unable to turn up any information on the effects of hypokinesis on the function of gonads. Little information is also available on metabolical reactions of birds exposed to hypokinesis. Nevertheless, it is well known from classical experiments (Selye, 1936) that stress situations result in lowering the level of glycogen and fat in tissues and increasing the level of glucose and fatty acids in the animals' circulatory system as instant energy to help overcome stress.

According to literary sources, bodily growth of laboratory mammals is significantly affected by hypokinesis. It causes loss of body weight (Pfeiffer, 1967; Gordienko, 1962). Hypokinesis does not produce any substantial changes in the body weight of humans. According to Helander (1961), restricted movement in laboratory mammals affects primarily the growth in the volume of skeletal muscles, while the growth of internal organs is less affected. Fedorov and Surova (1973) determined that slower growth in body weight is due primarily to changes in the protein metabolism of skeletal muscles. Their synthesis decreases simultaneously with an increase in proteolytic activity. They further determined that restricted activity causes increases in the levels of DNA and RNA in muscles occurring as a result of a lower ratio of sarcoplasma proteins to myofibrillae, which they ascribe to deficient proteosynthesis at transcription level due to blockage by appurtenant operons.

In view of the growing importance of the cage method of keeping fowl, the purpose of our project was to determine the effects of hypokinesis on the physiological functions and the productivity of chickens. At the same time, in view of the rapidly progressing use of technical resources in the medial employed, we also sought to determine the effects of stresses applied in the postincubation period.

Material and Methodology

In our experimental work we used cocks of the fattening hybrid Ross 1, that were divided after incubation by random selection into four groups, each consisting of 14 animals: the control group (K), a group exposed to postnatal stress (S), a group exposed to hypokinesis (H), and a group exposed to postnatal stress and hypokinesis (HS). Cocks in the groups S and HS were exposed to stress in their third postnatal week by being tied down to a supporting plate for one hour daily for five days. The cocks in the control group, as well as those in the experimental groups, were fed unrestricted amounts of feed mixture BR I and BR II, and were kept under identical conditions as regards temperature and light.

Birds in the experimental groups H and HS were exposed to hypokinesis at age of 109 days by being placed into individual metal cages, in which they could turn around only if they exerted extra effort, but were not actually compressed. After the conclusion of the experimental term, at age 144 days, we determined in the experimental birds their **body weight** and, after decapitation, which was preceded by being tied down for half an hour to a supporting plate (to determine the reaction of the experimental birds to outer stimuli), we determined the **weight of internal organs -- the liver**, kidneys, heart, selected muscles (M. gastronemius and m. fibularis), as well as the **weight** of the thyroid gland, the adrenal gland and testicles.

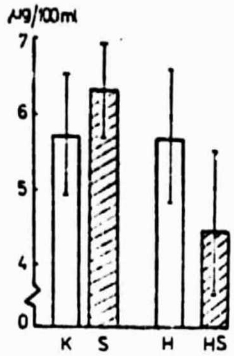
Activity of the thyroid gland was judged according to the contents of protein iodine (PBI) in the serum, determined according to Stolc corticosterone in the plasma, determined according to Van der Vies et al (1960). The levels of plasma testerone were determined by radio-immuno-analysis according to Furuyama (1970) and Dufau (1972) using the kit TESTOK/A 76 from the Sorin company. Intramuscular proteosynthesis was evaluated according to the contents of DNA and RNA in the m. gastrocnemius as determined by Pechan (1966). The intensity of proteolysis in muscles was deduced from the increase of residual nitrogen during 24 hours of incubation at a temperature of 37° C in a phosphate buffer. Residual nitrogen was determined according to Lowry et al (1951). In the same muscles we further studied the fat colorimetric method according to Duncomb (1963) by using Boehring's kit. The contents of glycogen were determined by the antronic method according to Horejsi et al (1964). Glucose was determined by the bio-test of the Lachema National Enterprize in Brno.

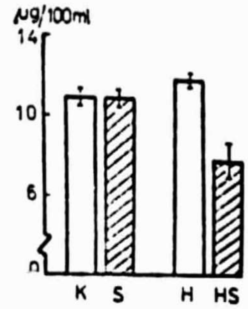
Statistical evaluation of the results was done through variance analysis and the significance of differences between groups was subjected to the Duncan test.

Results and Discussion /427

The endocrinous reactions of birds exposed to hypokinesis were subdued compared to the reactions of mammals (Illustration 1). Activity of the adrenal gland in cocks after hypokinesis had been applied for 35 days was comparable to that of the control group. However, hypo-kinesis applied to birds that were dubjected to stress (HS) during their third postnatal week, caused a lowering in the level of cortico-sterone in the plasma, reaching the level of statistical significance (P less than 0.1). Postnatal exposure caused in expermental birds (S) an increased reaction in the adrenal gland, which coincides with our findings made in previous projects (Nvota et al, 1970). Of some interest is our finding that hypokinesis in interaction with postnatal exposure to stress had a reverse effect on the activity of the adrenal cortex than had postnatal exposure to stress alone.

Activity of the thyroid gland was not significantly affected by hypokinesis alone (Illustration 2), but postincubational stress in interaction with hypokinesis, similarly to the adrenal gland, modified the response of the thyroid gland by significant lowering of its activity (P less than 0.05). This finding differs from the results obtained with rats, in the case of which hypokinesis caused significant increases in the thyroid gland activity. In the case of cocks, the reaction of the gonads to hypokinesis proved interesting. A 35 day



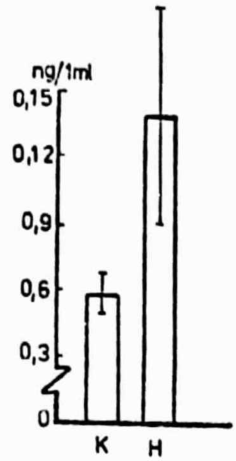


1. Changes in the corticosterone levels in plasma of experimental birds due to hypokinesis and post-incubation stress in µg per 100 ml of plasma.
(Average of 7-11 values plus-minus median average error) K - the control group, S - group exposed to hypokinesis, HS - group exposed to hypokinesis and postincubation stress (cross-hatched columns represent groups exposed to postincubation stress)

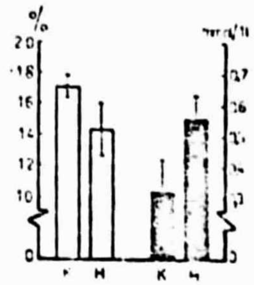
2. Changes in the protein-bound iodine levels in serum of experimental birds due to hypokinesis and postincubation stress in % (control group = 100 %)
(Average of 7-8 values plus-minus median avarage error. Designation of groups is the same as for Illustration 1.

exposure to hypokinesis produced increased levels of testosterone (Illustration 3), that proved statistically significant (P less than 0.05).

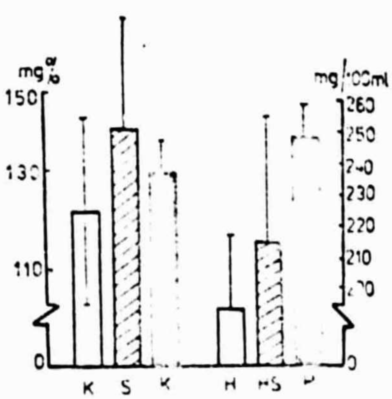
During 35-day long exposure to hypokinesis there were no significant /429
effects on the metabolism of fats and glycogen in muscles (Illustrations 4 and 5). On the one hand we determined the lowering of the contents of fat from glycogen in the thigh muscle (m. gastrocnemius), and on the other hand we determined increases in the level of nonesteric fatty acids and glucose in the circulatory system (Illustrations 4 and 5). Lowering in the levels of fat and glycogen in the thigh muscle obviously conincides with the mobilization of energy resources summoned to overcome the stress situation caused by hypokinesis. Also in this latter case, as can be seen from the glycogen and glucose contents, postembryonal stress significantly modified the response of the animal to the effects of their surrounding medium.



3. Changes in the testoste:·ne levels in plasma of experimental birds exposed to ng per 1 ml of plasma
Averages of 8-13 values plus-minus mean average error



4. Changes in fat content in the muscle and in N.E.F.A. levels in the plasma of cocks subject to hypokinesis
Blank columns represent changes in the contents of fat in a muscle caused by hypokinesis, expressed by percentage of dry matter in the muscle, filled-in columns represent changes in the level of fatty acids in the plasma of cocks due to hypokinesis, expressed in nmol per 1 liter. Average of 11-15 values, plus-minus mean average error. Designation of groups is the same as in Illustration 1.



5. Changes in the glycogen content in the muscle of experimental birds due to hypokinesis and post-incubation stress in mg per 100 g of wet muscle

Designation of groups same as in Illustration 1. Filled-in columns represent changes in the level of glucose in the plasma of cocks caused by hypokinesis, expressed in mg per 100 ml of plasma
(Averages of 9-11 values plus-minus mean average error)

TABLE 1. Survey of the body weight growth and relative weight of some internal organs, muscles and endocrine glands of experimental birds exposed to hypokinesis and postnatal stress

Group of experimental birds	Body weight prior to experiment	Body weight after exper.	Increase in body weight	Volume of organs per 100 g of body weight							
				Liver	kidney	heart	m. gastrocnemius	m. fibularus	thyroid gland	adrenal gland	testicles
Control	3462	4564	1102	14,17	2,84	4,25	16,57	5,17	0,111	0,058	1,70
Exposed to postnatal stress	3585	4905	1320	17,80	2,96	3,85	16,32	4,90	0,108	0,060	1,26
Exposed to hypokinesis	3470	4596	1126	16,37	2,79	4,10	17,46	5,12	0,090	0,052	1,86
Exposed to hypokinesis and postnatal stress	3472	4517	1044	17,39	2,80	4,23	16,35	5,24	0,089	0,059	1,77

Experimental birds kept increasing their body weight even after exposure to hypokinesis, same as did birds in the control group (Table 1). No substantial lack in growth of body weight could be found even in birds exposed to postnatal stress and then, at the age of 109 days, to a 35 day long hypokinesis. Differences in the growth rate between individual experimental groups and the control group had no statistical significance. A certain acceleration in growth was indicated in cocks exposed to postnatal stress. Politive effects of postnatal stress on the growth of chickens were determined by us already in our preceding projects (Nvota et al, 1970).

Hypokinesis did not produce in cocks, as could be expected by taking into account the growth of bodily volume, any significant growth in skeletal muscles (m. gastronemius and m. fibularis) or in internal organs (Table 1). Hypokinesis further failed to produce substantial changes in the contents of DNA (Illustration 6) and RNA (Illustration 7) in skeletal muscles. However, some characteristic trends could be detected in these changes. It appears that the lower level of DNA in the skeletal muscles of birds kept under hypokinesis may be due to the increased level of proteins (Illustration 8). A moderate increase in the contents of proteins in the m. gastrocnemius is obviously due to greater exertion of leg muscles in an attempt to free themselves from their confinement.

In addition to the mentioned increase in the contents of proteins /43
in the skeletal muscles of birds exposed to hypokinesis there was also an increase in the level of RNA which controls proteosynthesis in muscles. The latter fact, correlated to a significant increase in the level of residual nitrogen, with P less than 0.05 (Illustration 9), points toward an increased metabolism of proteins in the skeletal muscles, marked by an increased synthesis of proteins as well as their accelerated decomposition. It is obvious that proteosynthesis and proteolysis in the muscles of birds with restricted mobility, even though it may show an increase, is balanced, because their body weight, weight of muscles and internal organs showed no marked differences in comparison with the control birds. We failed to detect in the cocks any

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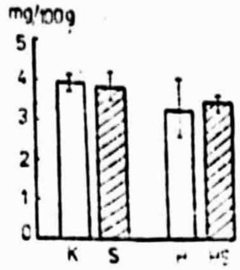
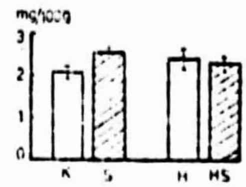
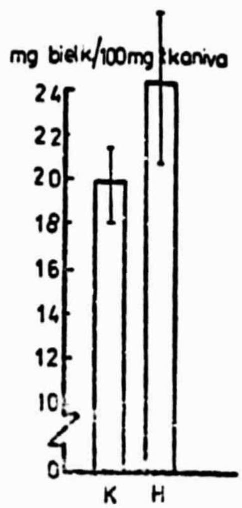


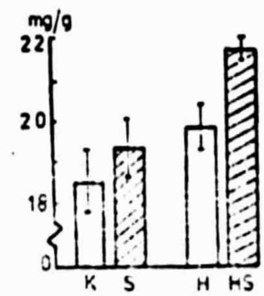
6. Changes in the DNA content in the muscle of experimental birds due to hypokinesis and post-incubation stress in mg per 100 g of wet muscle (Average of 6-13 values plus-minus mean average error). Designation of groups same as in Illustration 1.



7. Changes in the RNA content in the muscle of experimental birds due to hypokinesis and postincubation stress in mg P per 100 g of wet muscle (Average of 8-14 values plus-minus mean average error). Designation of groups same as in Illustration 1.



8. Changes in protein content in Musculus gastrocnemius of experimental cocks due to hypokinesis expressed in mg of proteins per 100 mg of wet muscle
K -- control group,
H -- group of birds exposed to hypokinesis



9. Changes in the increase of residual nitrogen in muscle after a 24-hour incubation at 37° C in phosphate buffer with a pH-value of 4.9 due to hypokinesis and postincubation stress in mg per 1 g of muscle
Average of 8-15 animals plus-minus mean average error. Designation of groups same as in Illustration 1.

deficiencies in the proteosynthesis of skeletal muscles, a fact found by Fedorov and Surova (1973) in rats. Our findings regarding the effects of hypokinesis in **body weight** in birds differ from the findings made in studies using laboratory rodents, in whom hypokinesis produced significant decreases in the growth of **body weight** (Pfieffer, 1967; Kravcuk and Oveckin, 1968; Gordienko, 1962). To a certain extent this finding could be interpreted as being due to the considerable phylogenetic remoteness of the compared species, and, possibly also, due to domestication, which provided the animals with extremely restricted living environment.

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